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Central and Arctic Region
Canadian Science Advisory Secretariat
Science Advisory Report 2013/003

ADVICE ON SIZE AND TREND OF THE CUMBERLAND SOUND BELUGA WHALE POPULATION, 1990 TO 2009

Beluga whale Delphinapterus leucas
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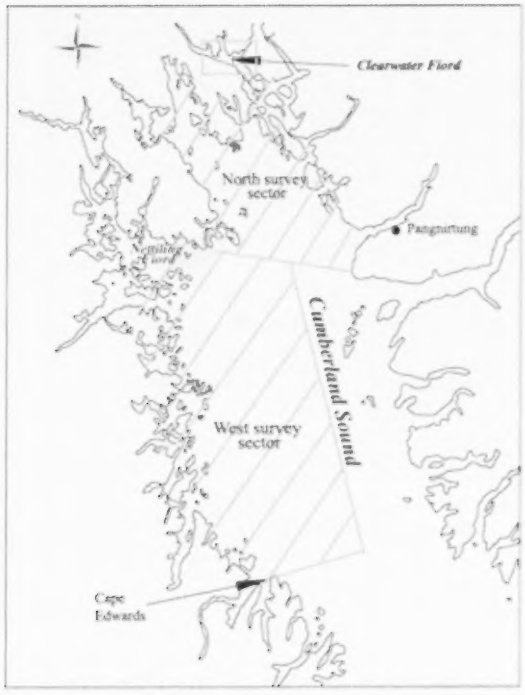

Figure 1. Study area showing survey sectors known to be used by Cumberland Sound belugas in summer.

Context

Inuit traditional knowledge and scientific studies have shown that most belugas in Cumberland Sound are from a population that is distinct from those hunted in other communities. Cumberland Sound belugas are managed as a distinct stock. Since 1998, Fisheries and Oceans Canada (DFO) and the Pangnirtung Hunters and Trappers Organization (HTO) have conducted research with which to update the population estimate for Cumberland Sound belugas. Information about movements and dive times, obtained from instrumented belugas, has increased the accuracy of population estimates derived from aerial surveys. Aerial surveys were flown in 1990 and 1999 and the latter showed that there were most likely about 1,960 belugas (90% confidence limits: 1,594 and 2,409) in Cumberland Sound in 1999 and that the population likely remains in or near Cumberland Sound year-round. Aerial surveys were conducted in August 2005, but poor weather affected survey coverage. As a result, it was not possible to determine trend in the number of belugas in Cumberland Sound. Aerial surveys were conducted again in August 2009 and the results presented here. DFO Science advice on population size may be used by DFO and the Nunavut Wildlife Management Board (NWMB) to update the beluga quota for Pangnirtung.

Canada

SUMMARY

- Results of an aerial survey in 2009 indicate that the number of belugas in surveyed areas was lower than those estimated 1999.
- Present population within the survey area on 2 August 2009 was estimated at 788 belugas (2.5-97.5 bootstrap percentiles = 310-1,679).
- Comparison of the population indices for the three years of surveys suggests they do not reflect the underlying population dynamics because they imply unrealistic rates of increase or total mortality. Consequently, there must be sampling error which is unaccounted for by the survey results.
- There are several possible sources of bias:
    1) differences in the proportion of the population that was sampled each survey year (i.e., some belugas were outside of the surveyed areas);
    2) inter-annual variation in the proportion of time that belugas spent at or near the surface during surveys;
    3) unmeasured differences in survey efficiency at detecting belugas (e.g., observer error, visibility conditions) between survey years;
    4) some aggregations of belugas were missed within the survey area.
- In view of these potential sources of uncertainty, it is recommended that Bayesian population dynamic modeling be conducted to see if unaccounted sources of error can be estimated from the model and to obtain a model estimate of the present population status of the Cumberland Sound population and the sustainable harvest.
- A new survey should be completed soon to better inform the trend analysis.

BACKGROUND

The Cumberland Sound population of beluga whales was commercially exploited for more than half a century by whalers and traders. Commercial exploitation declined over the years as the stock was depleted. Since the 1970s, this stock has been the subject of several research studies that concluded it was severely depleted and could not sustain a large take. In the early 1980s, numbers were estimated to be in the low hundreds and, for fear that the local subsistence hunt would endanger the population, a quota system was established to regulate the catches. Since 1990, four sets of surveys have been conducted to monitor the status of the population. Surveys done in 2005 were unsuccessful due to photographic problems and extreme weather. Three sets of surveys were successfully completed in 1990, 1999 and 2009. This document reports on the results of these surveys. The objective of the assessment was to update the abundance estimate of the Cumberland Sound beluga population and determine if adjustments to the current quota for Cumberland Sound belugas are needed.

ANALYSIS

Surveys were flown from a DeHavilland (DH6) Twin Otter in mid-summer of each year (Richard 2013). Surveys in Clearwater Fiord (Figure 1) were done by photographic passes over the area of beluga aggregation. For the 1990 and 1999 surveys, the plane was equipped with a large format film camera while in 2009 surveys were done using a pair of digital cameras. Visual strip

transect surveys were also conducted in the Northern sector of Cumberland Sound (Figure 1) in all three years and in the western Sector in 1999 and 2009. In most years, surveys were conducted for each sector two or three times.

The numbers of belugas counted within the three survey strata covered in 1-2 August 2009 were corrected for submerged animals, using the inverse of the proportion of time belugas spent near the surface. We used the proportion of time belugas spent at depths between 0 and 5 m to correct the visual counts for the Northern and Western sectors and at depths between 0 and 2 m to correct the photo counts for the more silted waters of Clearwater Fiord. The resulting corrected estimate for 2009 was 788 belugas (2.5-97.5 bootstrap percentiles = 310-1,679) (Table 1), which is much less than the previous estimate of 1,960 belugas (SE = 250) reported for 1999 (DFO 2005).

Table 1. Corrected stratum and total abundance estimates for 2009.

Date	Stratum	Surface estimate	CV	Dive Correction	CV	Corrected estimate	CV
2 Aug. 2009	CWF	118	-	2.36	0.077	279	0.077
2 Aug. 2009	N	190	0.660	2.37	0.050	450	0.662
1 Aug. 2009	W	25	0.245	2.37	0.050	59	0.432
Total						788	0.513

To study trend, the sums of the dive-corrected estimates from Clearwater Fiord and the Northern sector were used as indices to compare the population trend over those two decades (Table 2). The survey data for the Western strata were not used for the trend analysis because only a few sightings were made in 1999 and 2009 and no data were available for 1990.

Table 2. Sum of abundance estimates of Clearwater Fiord photo surveys and North stratum visual surveys on days when both survey types were conducted. Error ranges of the estimates are given by 2.5 and 97.5 percentiles (pc) of bootstrapped estimates.

Date	2.5 pc	Estimate	97.5 pc
8 Aug. 1990	989	1,087	1,202
6 Aug. 1999	1,877	2,207	2,554
7 Aug. 1999	1,837	1,977	2,197
2 Aug. 2009	279	728	1,600

These results suggest that the population increased between August 1990 and August 1999 by almost a factor of two and then declined by nearly a factor of three between August 1999 and August 2009 (Figure 2). This seems unlikely for two reasons. First, such an increase in ten years is considered biologically improbable, given that it would require an annual growth rate of around 7% while experiencing a catch of at least 35-40 animals, not counting hunting losses. Beluga populations are thought to be capable of a maximum rate of increase of about 4% per annum, if not hunted. Second, the severe decline implied by the 1999 and 2009 indices of abundance (Table 1) is only possible if hunting mortality was substantially larger (~180 belugas/year) than is presently reported (~42 belugas/year) or if there are other important sources of mortality acting on Cumberland Sound belugas that are not taken into account by the assumed maximum rate of increase, but these explanations seem unlikely. It is also possible that other sources of sampling error are affecting the surveys and that indices of abundance are not strictly comparable.

An alternative interpretation is that the trend is linear and the estimates are affected by a larger sampling error than the error bars for the 1990 and 1999 surveys, more in proportion to the

error bars for the 2009 survey (Figure 2). Unaccounted sampling error could be due to two things: undetected large groups in survey strata and inadequate survey coverage.

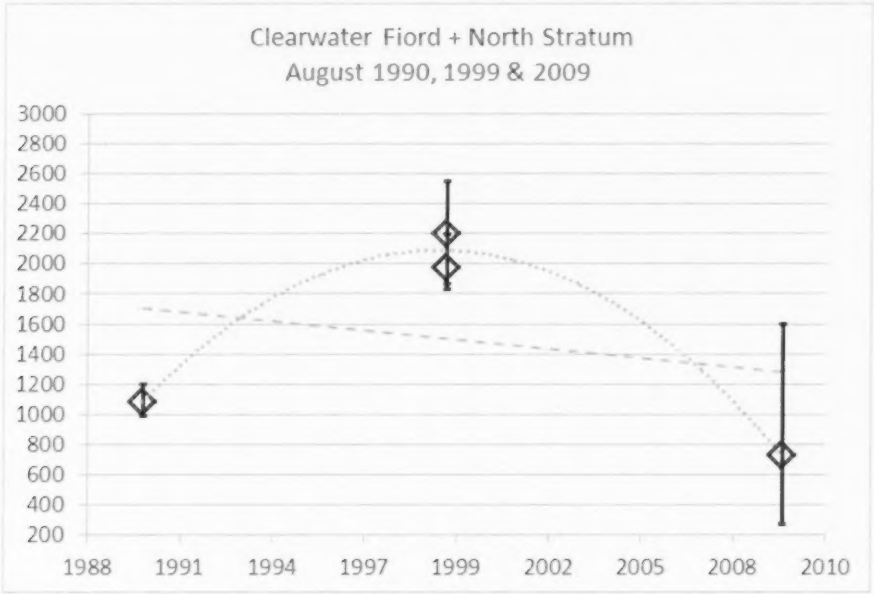

Figure 2. Trend in the sums of dive-corrected estimates from Clearwater Fiord photo counts and dive-corrected visual estimates of the North stratum flown on the same day, for August 1990, 1999 and 2009. 2.5 and 97.5 percentiles of bootstrapped estimates are given around the mean estimate. A linear fit (short dashed line) and a second-order polynomial fit (long dashed line) are also shown.

Sources of Uncertainty

There are several possible sources of bias in the survey results:

1) differences in the proportion of the population that was sampled each survey year (i.e., some belugas were outside of the surveyed areas);
2) inter-annual variation in the proportion of time that belugas spent at or near the surface during surveys;
3) unmeasured differences in survey efficiency at detecting belugas (e.g., observer error, visibility conditions);
4) some aggregations of belugas were missed within the survey area.

The surveyed strata were based on the traditional ecological knowledge of Pangnirtung beluga hunters and informed by tracking data but it is possible that both sources of information failed to observe the departure of belugas from the areas they typically occupy, resulting in some individuals being outside of the surveyed areas in some years.

Differences in diving behaviour of belugas during different surveys are not obvious given the within-year similarity in photo counts for Clearwater Fiord. Therefore, while this bias is possible it is thought to be unlikely.

Observer errors in detecting belugas and the effect of visibility conditions on detection may have varied between surveys but those effects have not been measured.

It is conceivable that belugas formed one or more large groups that escaped detection in some surveys, but not in others. The coastline of Cumberland Sound is convoluted and peppered with islands so it is possible that large groups or herds were missed. For example, a group of 17 belugas was seen during a visual reconnaissance survey of the coastline of the North stratum on 10 August 1990, when no sighting had been made during systematic surveys of the same stratum a day before. Another example occurred during the survey on 2 August 2009 when 40 belugas were sighted clustered on a single transect with none or a single animal on nearby transects.

CONCLUSIONS

The present size and trend in numbers of Cumberland Sound belugas is uncertain. In view of the potential sources of uncertainty, it is recommended that Bayesian population dynamic modeling be conducted to see if unaccounted sources of error can be estimated from the model and to obtain a model estimate of the present population status of the Cumberland Sound population and the sustainable harvest. A new survey should be completed soon to better inform the trend analysis.

SOURCES OF INFORMATION

This Science Advisory Report is from the November 22-26, 2010 National Marine Mammal Peer Review Committee Meeting (NMMPRC). Additional publications from this process will be posted as they become available on the Fisheries and Oceans Canada Science Advisory Schedule.

Richard, P.R. 2013. Size and trend of the Cumberland Sound beluga whale population, 1990 to 2009. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/159. iii + 28 p.

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ISSN 1919-5087
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Correct citation for this publication:

DFO. 2013. Advice on size and trend of the Cumberland Sound beluga whale population, 1990 to 2009. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/003.

Aussi disponible en français:

MPO. 2013. Avis scientifique sur la taille et les tendances de la population de bélugas de la baie Cumberland, de 1990 à 2009. Secr. can. de consult. sci. du MPO, Avis sci. 2013/003.

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